

Pos #14



US ARMY SIGNAL SCHOOL
FORT GORDON, GEORGIA 30905

OPERATION OF OSCILLOSCOPE AN/USM-281C



TEC Lesson No. 101-113-4782A

OPERATION OF OSCILLOSCOPE AN/USM-281C

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STUDENT INSTRUCTION SHEET

AUDIENCE:

Applicable to Users of Oscilloscope
AN/USM-281C

TRAINING OBJECTIVES:

Adjusting the oscilloscope for a trace.
Calibrating the oscilloscope for single
channel operations. Displaying a stable
waveform and computing its frequency. Com-
paring and adding two signals algebraically.

MATERIALS REQUIRED:

Oscilloscope AN/USM-281C

TIME:**REFERENCE:**

NAVELEX 0969-161-9020

GENERAL INSTRUCTIONS:

Work through the lesson as many times as
necessary to master the skills and
knowledge taught.

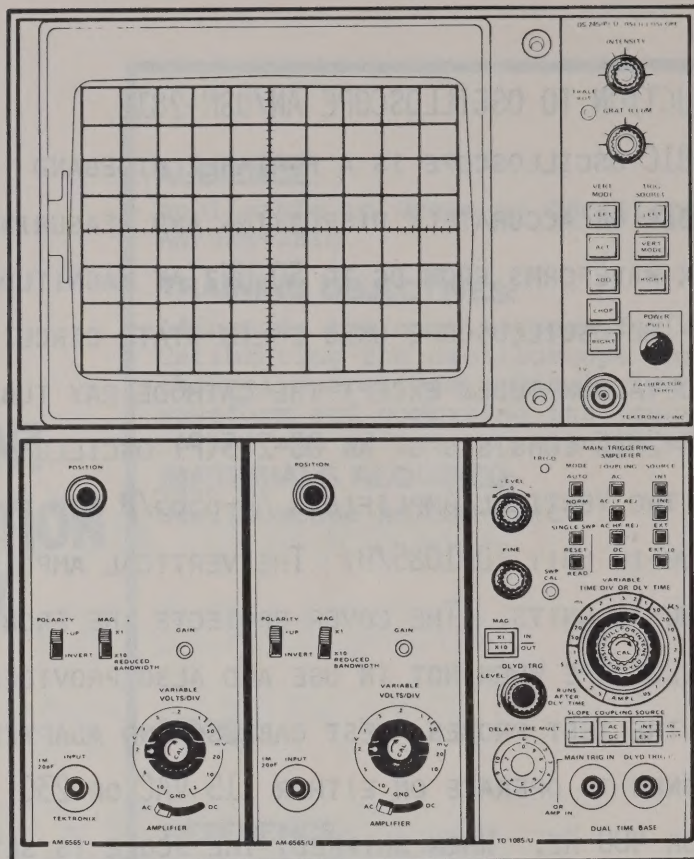
FOLLOW INSTRUCTIONS. DO NOT TAKE SHORTCUTS.

PREREQUISITES:

None

INTRODUCTION TO OSCILLOSCOPE AN/USM-281C

THE AN/USM-281C OSCILLOSCOPE IS A PORTABLE WIDEBAND OSCILLOSCOPE CAPABLE OF ACCURATELY DISPLAYING AND MEASURING SIMPLE AND COMPLEX WAVEFORMS FROM DC TO 50 MHz AT MAGNITUDES UP TO 500 VOLTS. THE OSCILLOSCOPE USES SOLID-STATE CIRCUITRY THROUGHOUT WITH NO VACUUM TUBES EXCEPT THE CATHODE RAY TUBE (CRT). THE AN/USM-281C CONSISTS OF AN OS-245(P) OSCILLOSCOPE MAIN FRAME, TWO VERTICAL AMPLIFIERS AM-6565/U AND A DUAL TIME BASE PLUG-IN UNIT TD-1085/U. THE VERTICAL AMPLIFIERS ARE ALSO PLUG-IN UNITS. THE COVER PROTECTS THE FRONT PANEL OF THE OSCILLOSCOPE WHEN NOT IN USE AND ALSO PROVIDES STORAGE SPACE FOR THE TEST PROBES, TEST CABLES, AND ADAPTERS. THE SCOPE IS DESIGNED TO OPERATE ON EITHER 115 VAC OR 230 VAC, 50 OR 60 Hz OR 400 Hz. WHEN SHIPPED, THE SCOPE IS SET FOR 115 VAC. FOR OTHER POWER INPUTS, TECHNICAL CHARACTERISTICS, AND OTHER PERTINENT DATA, REFER TO NAVALEX 0969-161-9020.



LET'S BEGIN YOUR TRAINING BY HAVING YOU TURN ON AND ADJUST THE AN/USM-281C AS OUTLINED. YOU WILL BE GIVEN A STEP-BY-STEP PROCEDURE FOR OPERATING THE OSCILLOSCOPE. WHEN YOU HAVE COMPLETED THESE STEPS, HAVE A QUALIFIED OPERATOR CHECK YOUR SETUP TO MAKE SURE YOU ARE CORRECT.

ADJUST THE AN/USM-281C OSCILLOSCOPE FOR A TRACE

NAME AND LOCATION OF AN/USM-281C OSCILLOSCOPE CONTROLS

THE CONTROLS FOR THE AN/USM-281C ARE LOCATED ON THE FRONT COVER OF THE SCOPE. USE THE FOLDOUT IN BACK OF THIS BOOKLET TO LEARN THE LOCATION OF THE CONTROLS. AS A CONTROL IS DISCUSSED, PRESET IT TO ITS APPROPRIATE POSITION. IF THE CONTROL APPEARS TO BE IN THE CORRECT POSITION, MOVE IT ANYWAY TO INSURE THAT IT IS PROPERLY SEATED.

SOME OF THE CONTROLS FOR THE AN/USM-281C WILL NOT BE DISCUSSED IN THIS TEXT. THESE CONTROLS ARE FOR SPECIAL APPLICATIONS. REFER TO NAVALEX 0969-161-9020 FOR THEIR USES. TURN ON AND ADJUSTMENT PROCEDURE

NOTE: PERFORM THE INITIAL CONTROL SETTINGS BEFORE TURNING THE OSCILLOSCOPE ON FOR THE FIRST TIME. ONCE THE SCOPE HAS BEEN IN USE, IT SHOULD NOT BE NECESSARY TO REPEAT THE INITIAL CONTROL SETTINGS

UNLESS THE FRONT PANEL CONTROLS HAVE BEEN
COMPLETELY MALADJUSTED.

INITIAL CONTROL SETTINGS

POSITION THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

1. MAIN FRAME CONTROLS

- A. SET INTENSITY No 1 FULLY COUNTERCLOCKWISE.
- B. TURN FOCUS (2) TO MIDRANGE.
- C. BEAM FINDER (5) IS NOT PRESSED.
- D. TURN GRAT ILLUM (4) TO MIDRANGE.
- E. SET VERT MODE LEFT (6) BY PRESSING IN.

NOTE: BE SURE ONLY ONE VERT MODE SWITCH REMAINS PRESSED
IN.

- F. TRIG SOURCE VERT MODE SWITCH (12) PRESSED IN.

NOTE: BE SURE ONLY ONE TRIG SOURCE SWITCH REMAINS
PRESSED IN.

2. VERTICAL AMPLIFIER CONTROLS

NOTE: USE THE LEFT AMPLIFIER FOR THIS LESSON; HOWEVER,
LIKE CONTROLS AND SETTINGS MAY BE USED IF RIGHT
AMPLIFIER IS TO BE USED.

- A. SET POSITION CONTROL (16) TO MIDRANGE. THIS CONTROL
ALLOWS FOR VERTICAL MOVEMENT OF DISPLAYED WAVEFORM.
- B. SET POLARITY (17) TO +UP POSITION.
- C. SET MAG (18) TO X1 POSITION.
- D. TURN VOLTS/DIV SWITCH (21) TO 2V.

ISSUE THIS CHANGE WITH EACH DS-GS MANUAL

This is a change to Receive Logic Diagram (Figure 6-28.1) and to Receive Timing Panel 11A28 Schematic Diagram (Figure 6-44.2).

Make the following changes to the Receive Timing Panel Diagrams.

1. Transistor Q2 has been deleted.
2. Pulse Shaper Z-23 pin 2 is not connected.
3. Squelch inhibit input at J-10 pin 37 is connected to Module Z-26 pin 5.

MAKE THESE CORRECTIONS BEFORE STARTING WORK ON YOUR PERFORMANCE GUIDE !!!

E. TURN VARIABLE (RED KNOB) (22) FULLY CLOCKWISE UNTIL IT CLICKS IN PLACE.

F. SET AC/GND/DC SWITCH (23) TO AC.

3. DUAL TIME BASE CONTROLS

A. TURN LEVEL (24) TO MIDRANGE.

B. TURN SLOPE (25) TO +.

C. MODE SWITCHES AUTO (27) SHOULD BE PRESSED IN.

D. COUPLING SWITCHES AC (31) SHOULD BE PRESSED IN.

E. SOURCE SWITCHES INT (35) SHOULD BE PRESSED IN.

NOTE: THERE ARE FOUR SWITCHES IN EACH GROUP.

ONLY ONE SWITCH AT A TIME SHOULD BE PRESSED IN.

F. TURN POSITION (39) AND FINE (40) KNOBS TO MIDRANGE.

THESE CONTROLS ALLOW FOR HORIZONTAL MOVEMENT OF DISPLAYED WAVEFORM.

G. PUSH MAG BUTTON (42) IN TO X1.

NOTE: TIME/DIV OR DLY TIME SWITCH IS FOUR CONTROLS IN ONE. CARE MUST BE TAKEN TO SEE THAT EACH IS POSITIONED PROPERLY.

H. SET TIME/DIV OR DLY TIME SWITCH (43) TO THE 1MS POSITION.

I. SET DELAYED TIME/DIVISION SWITCH (44) TO THE 1MS POSITION AND PUSH IN.

J. TURN VARIABLE (RED KNOB) (45) FULLY CLOCKWISE UNTIL IT CLICKS IN PLACE.

K. TURN DLY'D TRIG (46) FULLY CLOCKWISE TO THE RUNS AFTER DLY TIME POSITION.

L. PRESS THE SLOPE (47), COUPLING (43) AND SOURCE (49) PUSHBUTTON IN.

M. TURN DELAY TIME MULT KNOB (50) TO THE 1.0 POSITION.

4. TURN ON AND ADJUSTMENT FOR SINGLE TRACE

A. CONNECT OSCILLOSCOPE POWER CORD TO A POWER COURSE OF PROPER VOLTAGE AND FREQUENCY.

B. PULL POWER SWITCH KNOB (14) OUT TO APPLY POWER AND ALLOW THE SCOPE TO WARM UP FOR AT LEAST 5 MINUTES. TURN GRAT ILLUM (4) UNTIL SCALE IS VISIBLE ON THE FACE OF THE CRT.

C. TURN INTENSITY (1) CLOCKWISE UNTIL DISPLAY IS VISIBLE. IF NO DISPLAY IS VISIBLE BY MIDRANGE, PERFORM THE FOLLOWING PROCEDURE.

D. PRESS AND HOLD THE BEAM FINDER SWITCH.

E. SET VOLTS/DIV SWITCH ON VERTICAL AMPLIFIER FOR DISPALY THAT REMAINS WITHIN VERTICAL AREA OF SCREEN.

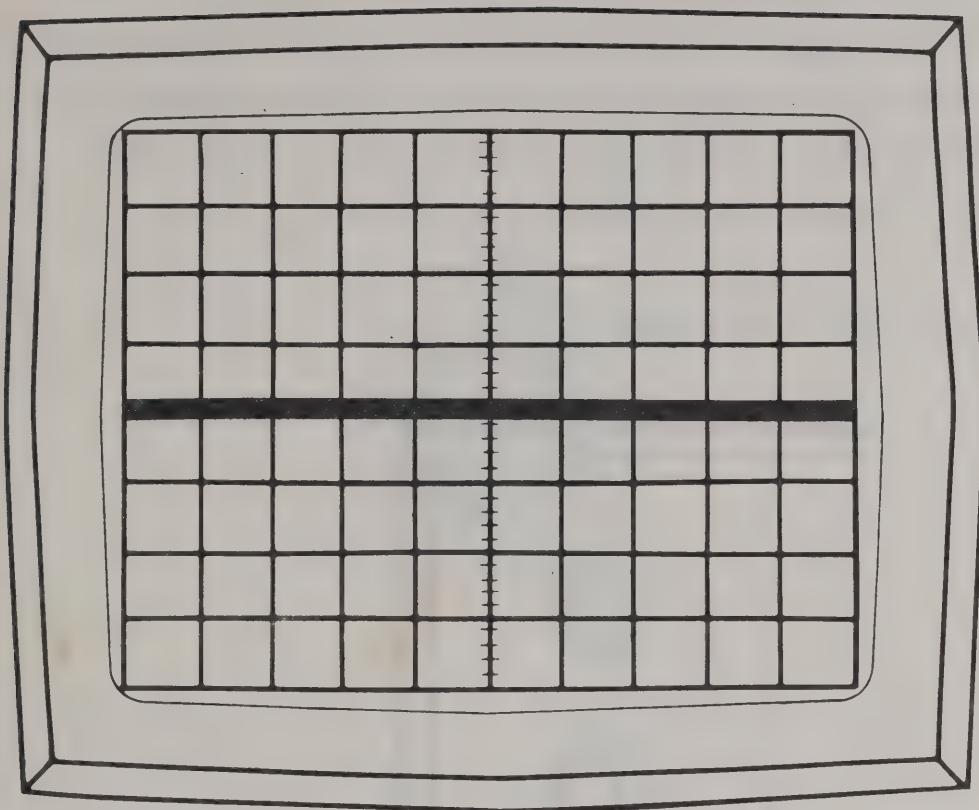
F. ADJUST POSITION CONTROL ON VERTICAL AMPLIFIER FOR DESIRED POSITION OF DISPLAY.

G. ADJUST POSITION CONTROL ON DUAL TIME BASE FOR DESIRED HORIZONTAL POSITION OF DISPLAY.

H. RELEASE BEAM FINDER SWITCH.

I. IF NECESSARY, ADJUST LEVEL CONTROL ON DUAL TIME BASE FOR STABLE DISPLAY.

J. ADJUST FOCUS CONTROL FOR WELL DEFINED DISPLAY.

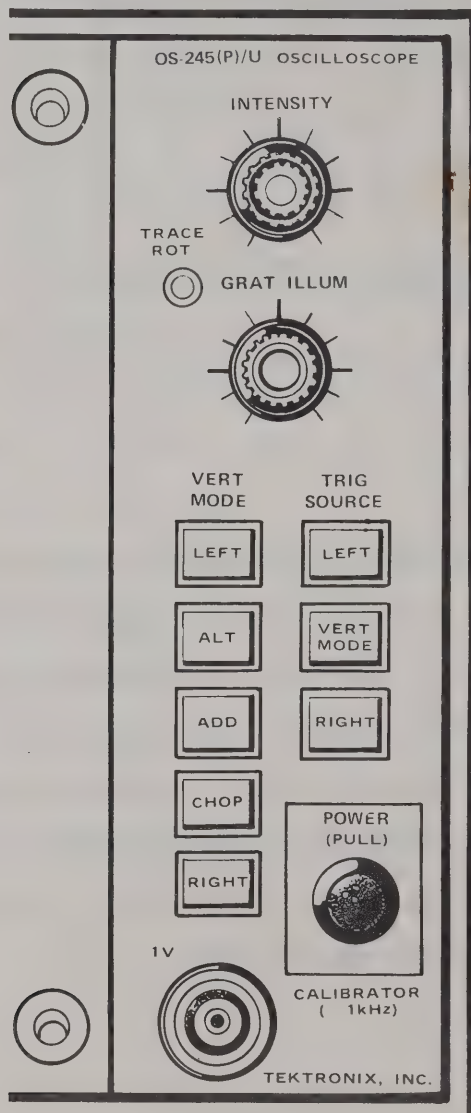


WHEN YOU HAVE COMPLETED THE ABOVE STEPS, THE SCOPE IS TURNED ON AND ADJUSTED FOR A TRACE. HAVE A QUALIFIED OPERATOR CHECK YOUR WORK TO BE SURE YOU HAVE MADE NO MISTAKES. SET ALL OF THE CONTROLS TO RANDOM SETTINGS. PRACTICE TURNING ON AND OBTAINING A TRACE ON THE SCOPE UNTIL YOU ARE PROFICIENT. EACH TIME HAVE A QUALIFIED OPERATOR CHECK YOUR WORK. WHEN YOU ARE SURE YOU CAN ADJUST THE OSCILLOSCOPE FOR A TRACE WITHIN FIVE MINUTES, YOU CAN MOVE ON TO THE NEXT STEPS.

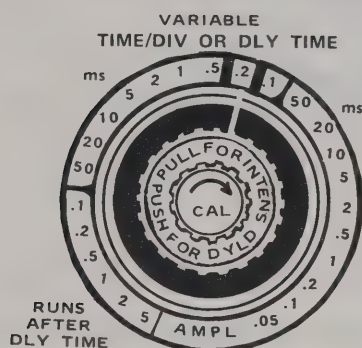
SINGLE CHANNEL OPERATING PROCEDURE

NOW THAT YOU ARE ABLE TO PERFORM THE TURN-ON PROCEDURE AND ADJUST THE OSCILLOSCOPE FOR A STABLE TRACE, YOU ARE READY TO DISPLAY A SIGNAL, AND MEASURE ITS AMPLITUDE.

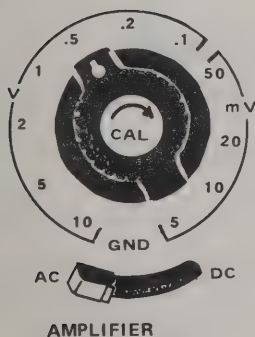
PERFORM TURN-ON PROCEDURE.



UNDER VERT MODE COLUMN OF PUSH BUTTONS, PRESS LEFT BUTTON IN. FOR A SINGLE TRACE EITHER CHANNEL MAY BE USED. IF RIGHT VERTICAL AMPLIFIER IS TO BE USED, PRESS RIGHT BUTTON IN.



THE TIME/DIV OR DLY TIME CONTROL CONSISTS OF FOUR CONTROLS IN ONE. SET THE RED VARIABLE SWEEP SWITCH FULLY CLOCKWISE UNTIL IT CLICKS. SET THE INNERMOST TIME/DIV OR DLY TIME SWITCH TO THE .2 MS POSITION. SET THE GREY INTENS SWITCH TO THE .2 MS POSITION AND PUSH IN. THIS MEANS THAT EACH HORIZONTAL SQUARE WILL EQUAL .2 MILLISECONDS OF TIME.

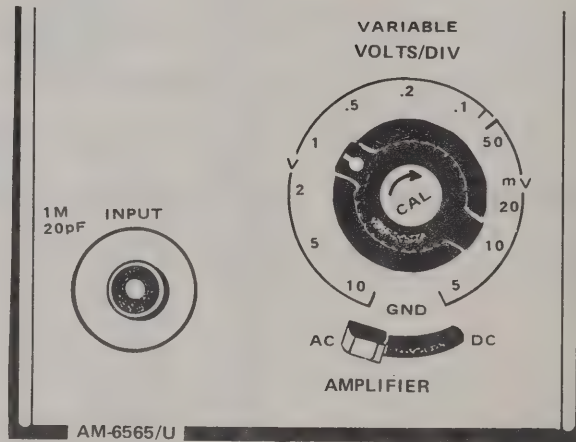
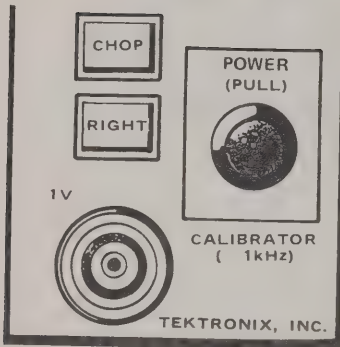


PLACE INPUT COUPLING AC/GND/DC SWITCH TO THE AC POSITION.



SET THE VOLTS/DIV SWITCH TO THE .5 VOLTS POSITION. THIS MEANS THAT EACH VERTICAL SQUARE ON THE SCREEN IS EQUAL TO .5 VOLTS OF INPUT SIGNAL.

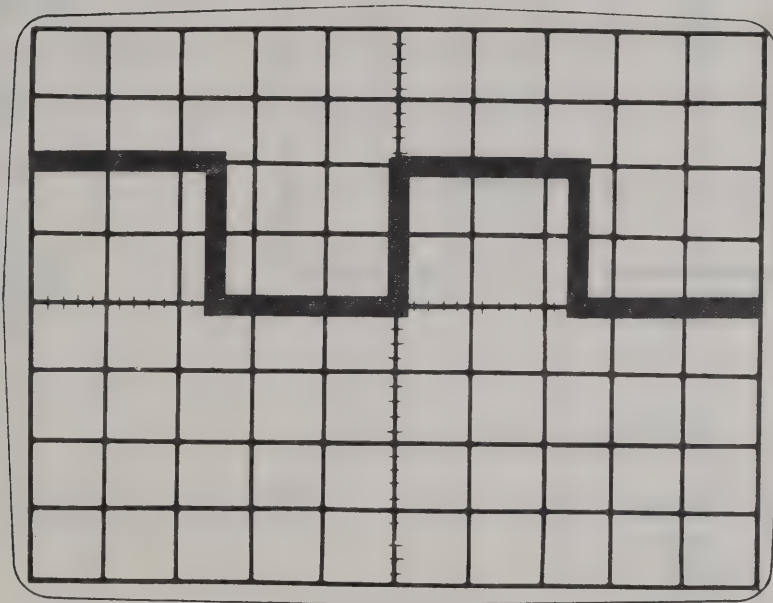
TURN THE RED VARIABLE VOLTS/DIV SWITCH FULLY CLOCKWISE UNTIL IT CLICKS.



REMOVE FROM THE COVER A CABLE EQUIPPED WITH A BNC CONNECTOR ON EACH END.

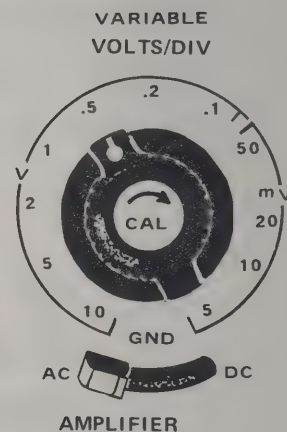
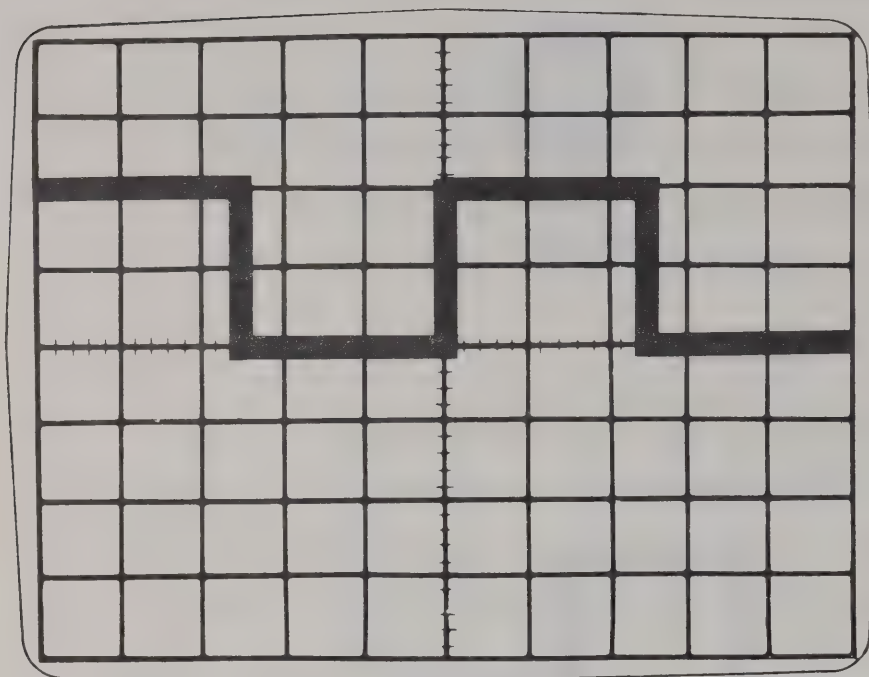
CONNECT ONE END OF THE CABLE TO THE CALIBRATE (15) AND THE OTHER END TO THE INPUT CONNECTOR OF THE LEFT VERTICAL AMPLIFIER.

YOU SHOULD HAVE TWO COMPLETE CYCLES OF SQUARE WAVE DISPLAYED ON THE SCREEN. IT MAY BE NECESSARY TO ADJUST THE LEVEL CONTROL TO OBTAIN A STABLE DISPLAY. ADJUST BOTH POSITION CONTROLS TO CENTER THE DISPLAYED WAVEFORM.



THESE TWO CYCLES SHOULD BE TWO SQUARES HIGH. THE VOLTAGE OF THIS SQUARE WAVE IS 1V PEAK-TO-PEAK. WE CALCULATED THE VOLTAGE IN THIS MANNER. THE NUMBER OF CENTIMETERS (CM) OR GRID SQUARES OF VERTICAL DEFLECTION OF SIGNAL AMPLITUDE, TIMES THE SETTING OF VOLTS/DIV SWITCH, EQUALS PEAK-TO-PEAK VOLTAGE OF INPUT SIGNAL.

NUMBER OF CM'S OF SIGNAL AMPLITUDE X VOLTS/DIV SWITCH
SETTING = PEAK-TO-PEAK VOLTAGE OF DISPLAYED SIGNAL.

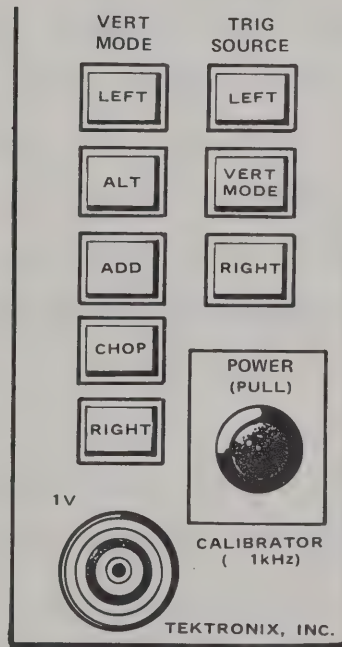
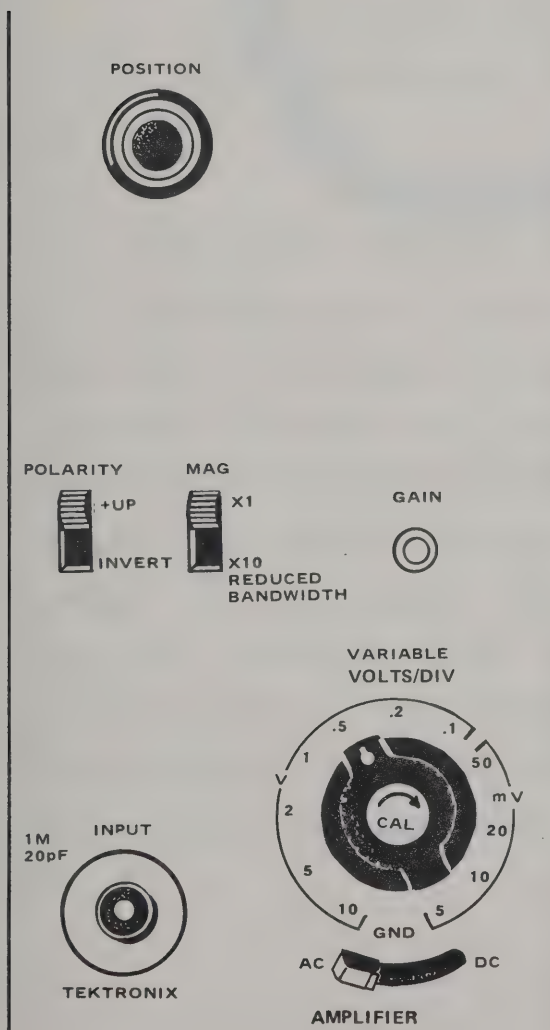


COMPUTE THE FOLLOWING VOLTAGES.

CM'S OF SIGNAL AMPLITUDE	VOLTS/DIV SWITCH SETTING
2	5
4	.5
7	10
6	50 mV
3	2

YOUR ANSWERS SHOULD BE 10, 2, 70, .3, AND 6 VOLTS
RESPECTIVELY.

USING THE FORMULA, YOU WILL BE ABLE TO CALCULATE THE PEAK-TO-PEAK VOLTAGE OF THE DISPLAYED WAVEFORM. YOUR ANSWER SHOULD BE 1 VOLT. IF IT IS NOT, THE VERTICAL AMPLIFIER IS OUT OF CALIBRATION. IF YOUR SCOPE IS OUT OF CALIBRATION, ASK A QUALIFIED OPERATOR TO CALIBRATE IT ACCORDING TO THE PROCEDURE IN NAVALEX 0969-161-9010. THE AN/USM-281C HAS A DUAL TRACE CAPABILITY. THE SECOND TRACE, RIGHT VERTICAL AMPLIFIER, HAS THE SAME CONTROLS AS THE LEFT AMPLIFIER. THEY ALL FUNCTION THE SAME AS THE LEFT AMPLIFIER. TO USE THE RIGHT INPUT AND VERTICAL AMPLIFIER, YOU MUST PRESS THE RIGHT PUSH BUTTON UNDER THE VERT MODE COLUMN OF CONTROLS.



SET THE CONTROLS TO RANDOM SETTINGS THEN PRACTICE CALIBRATING THE OSCILLOSCOPE UNTIL YOU CAN CALIBRATE BOTH CHANNELS WITHIN FIVE MINUTES.

THROUGHOUT THIS EXERCISE WE HAVE USED A DIRECT INPUT TO THE OSCILLOSCOPE. WHEN WE WANT TO TEST MOST CIRCUITS, WE MUST USE A PROBE. THERE ARE TWO PROBES ISSUED WITH THE AN/USM-281C.

BOTH PROBES HAVE AN ATTENUATION FACTOR OF TEN. IN OTHER WORDS, THE SIGNAL STRENGTH IS REDUCED BY TEN WITHIN THE PROBE.

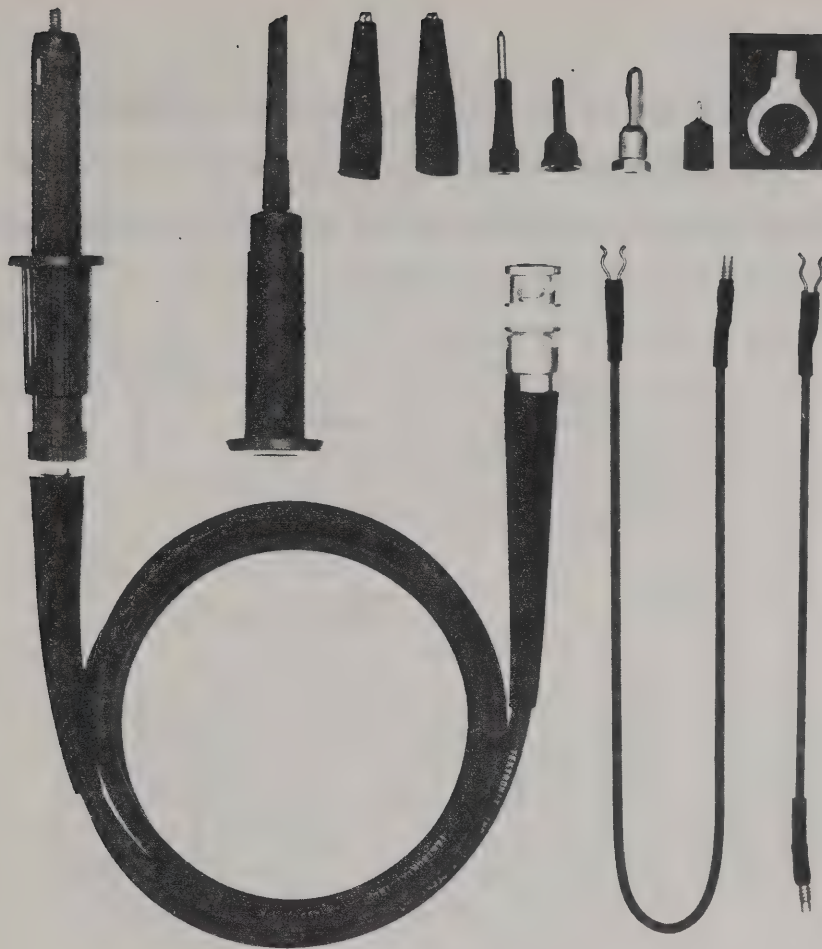
USING THE PROBE, WE MUST ADD AN ADDITIONAL STEP TO THE PROCEDURE FOR COMPUTING THE VOLTAGE. WHEN USING A PROBE, THE FORMULA FOR COMPUTING VOLTAGE IS:

NUMBER OF CM'S OF SIGNAL AMPLITUDE X VOLTS/DIV SWITCH
SETTING X ATTENUATION FACTOR OF PROBE = PEAK-TO-PEAK VOLTAGE OF
DEPLOYED SIGNAL.

COMPUTE THE FOLLOWING VOLTAGES.

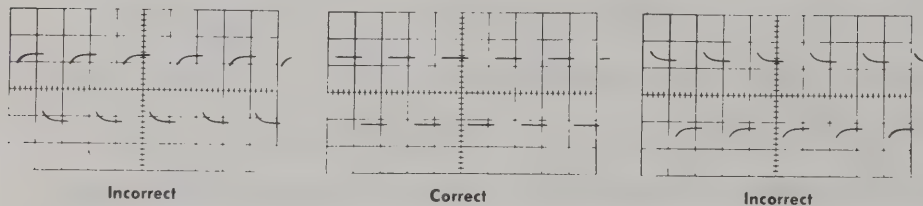
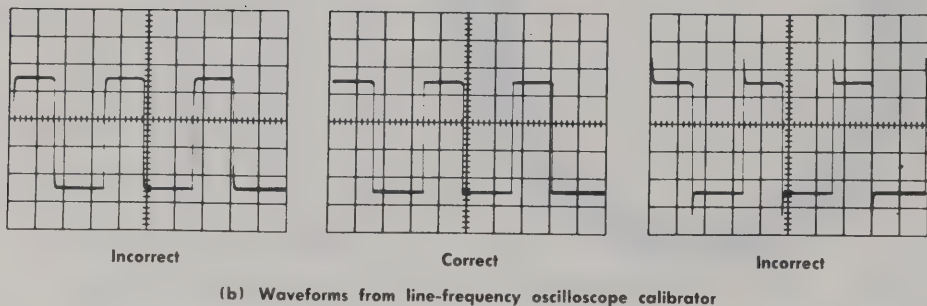
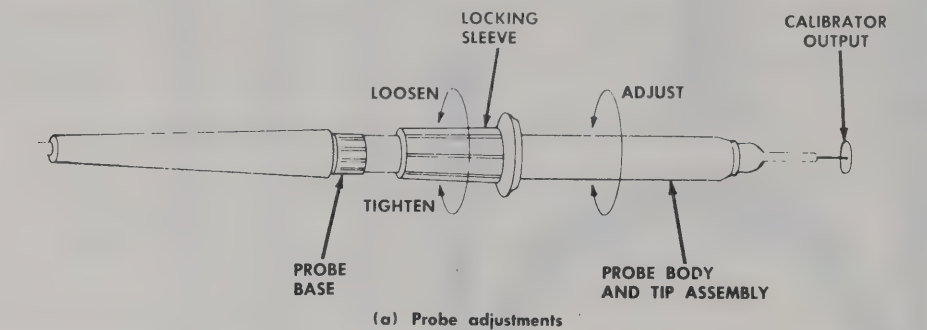
VOLTS/DIV SWITCH	CM'S OF SIGNAL AMPLITUDE	PROBE FACTOR
1	6	10
10	4	10
.5	5	10

YOUR ANSWERS SHOULD BE 60, 400, AND 25 VOLTS RESPECTIVELY.



THE PROBE HAS FIVE KINDS OF TIPS AND TWO ALLIGATOR CLIPS. THE TIPS MAY BE CHANGED BY UNSCREWING THE END OF THE PROBE AND SCREWING THE DESIRED TIP IN PLACE. A GROUNDING STRAP IS ALSO ISSUED WITH THE PROBE. THE SPRING CLIP OF THE GROUNDING STRAP CLAMPS OVER THE BARED PORTION OF CABLE AT THE UPPER END OF THE PROBE. THE OTHER END OF THE GROUNDING STRAP USES AN ALLIGATOR CLIP AS A CONNECTION TO THE CIRCUIT UNDER TEST. THIS HELPS COMPLETE THE CONNECTION BETWEEN EQUIPMENT UNDER TEST AND THE OSCILLOSCOPE. IT PREVENTS ELECTRICAL SHOCK WHEN TOUCHING THE OSCILLOSCOPE AND EQUIPMENT UNDER TEST AT THE SAME TIME.

WHEN A PROBE IS USED WITH AN OSCILLOSCOPE FOR THE FIRST TIME OR WHEN IT IS TRANSFERRED FROM ONE PLUG IN UNIT TO ANOTHER, IT (THE PROBE) MUST BE ADJUSTED OR COMPENSATED. THIS WILL ENSURE ACCURATE ATTENUATION OF SIGNALS.



TO COMPENSATE THE PROBE, TOUCH THE PROBE TIP TO THE CALIBRATOR OUTPUT JACK AND DISPLAY SEVERAL CYCLES OF THE SIGNAL. LOOSEN THE FLANGED LOCKING SLEEVE AND TURN THE PROBE BODY AND TIP ASSEMBLY UNTIL THE CORRECT WAVEFORM IS DISPLAYED ON THE CRT. REFER TO THE THREE WAVEFORMS SHOWN FOR CORRECT AND INCORRECT DISPLAYS. ALSO SHOWN IS A DRAWING OF THE PROBE

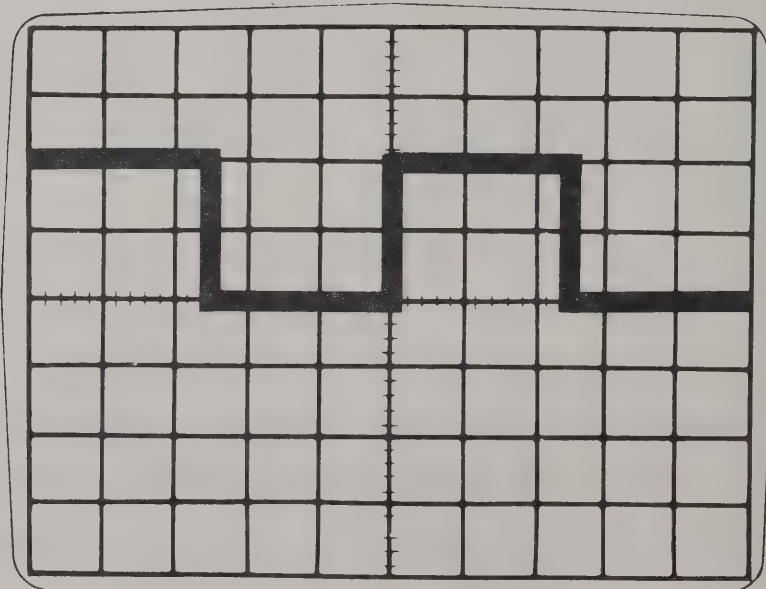
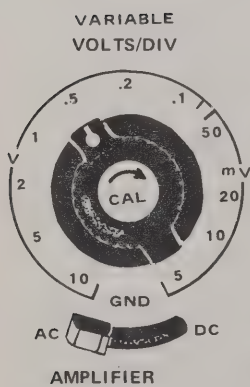
SHOWING THIS ADJUSTMENT. AFTER THE CORRECT ADJUSTMENT HAS BEEN MADE, HOLD THE PROBE BODY AND TURN ITS BASE UNTIL IT IS LOCKED IN PLACE. FOR ADDITIONAL INFORMATION CONCERNING THE PROBE REFER TO TEKTRONIX INSTRUCTION MANUAL FOR PROBE P6006.

NOW THAT YOU CAN MEASURE THE AMPLITUDE OF A SIGNAL, YOU WILL NEED TO BE ABLE TO DETERMINE ITS FREQUENCY.

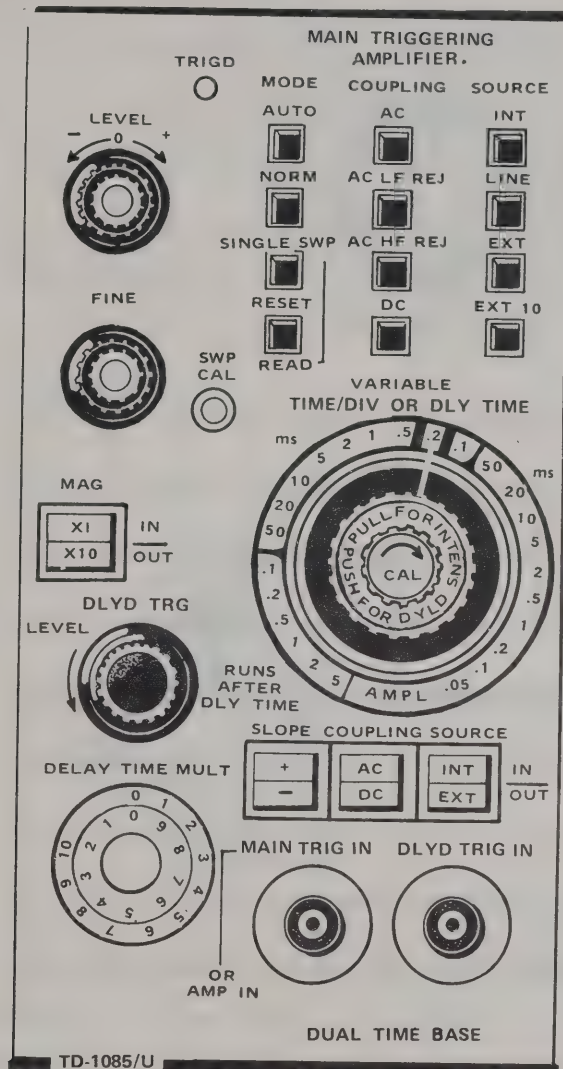
DISPLAY A STABLE WAVEFORM AND USE THE TIME BASE AND
DELAY GENERATOR TO COMPUTE ITS FREQUENCY

DISPLAY THE OUTPUT FROM THE CALIBRATOR ON THE LEFT
CHANNEL.

SET THE VOLTS/DIV SWITCH TO .5V PER CM. THE SIGNAL
SHOULD CONTAIN 2 CM'S VERTICALLY AS IN THE PREVIOUS SECTION.

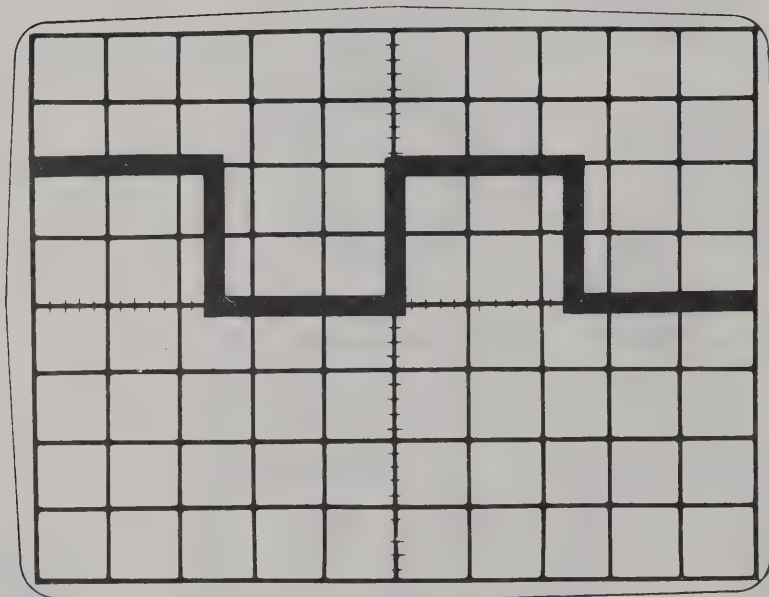
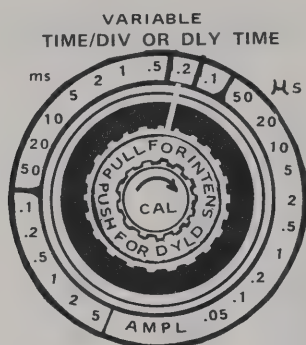


TO CALCULATE THE FREQUENCY OF A SIGNAL, WE MUST USE THE CONTROLS OF THE DUAL TIME BASE GENERATOR. IT DETERMINES THE HORIZONTAL DISPLAY OF THE WAVEFORM UPON THE CRT.



THE TIME/DIV OR DLY TIME SWITCH CONTROLS THE HORIZONTAL DISPLAY OF THE SCOPE. IT SHOULD BE SET AT .2 MILLISEC TO

OBTAIN 2 COMPLETE CYCLES ON THE SCREEN. WHENEVER YOU CHANGE SIGNALS OR THE TIME/DIV SWITCH, IT MAY BE NECESSARY TO ADJUST THE LEVEL TO STABILIZE THE SIGNAL.



THERE ARE TWO COMPLETE CYCLES DISPLAYED. VERTICAL DEFLECTION IS 2 CM'S OR 1 VOLT. COUNT THE NUMBER OF CM'S OF HORIZONTAL DEFLECTION FOR 1 CYCLE. BEFORE WE CAN CALCULATE THE FREQUENCY, WE MUST FIRST COMPUTE THE TIME DURATION OF THE SIGNAL. USE THIS FORMULA.

TIME DURATION = (HORIZONTAL DEFLECTION) X (HORIZONTAL SWEEP)
 (IN CM FOR 1 CYCLE) (SETTING IN SECONDS)

TIME DURATION = (5 CM) X (.2 MILLISECONDS)

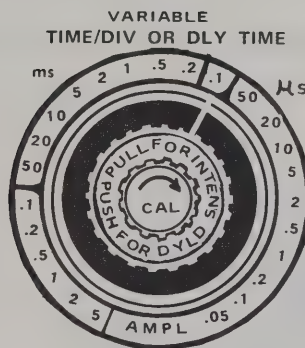
TIME DURATION = 1.0 MILLISECOND

TO DETERMINE THE FREQUENCY, USE THIS FORMULA.

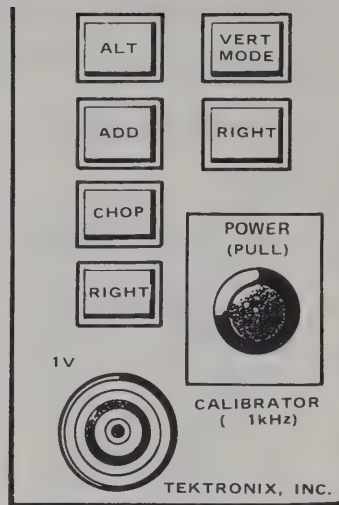
FREQUENCY = $\frac{1}{\text{TIME DURATION}}$

FREQUENCY = $\frac{1}{\text{MILLISECOND}} = \frac{1}{.001 \text{ (MILLISECOND CONVERTED TO SECOND)}}$

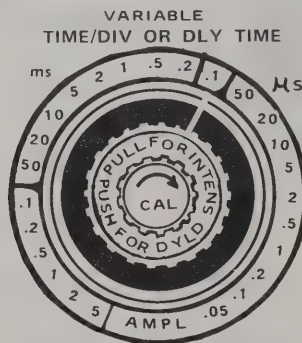
FREQUENCY = 1000 Hz



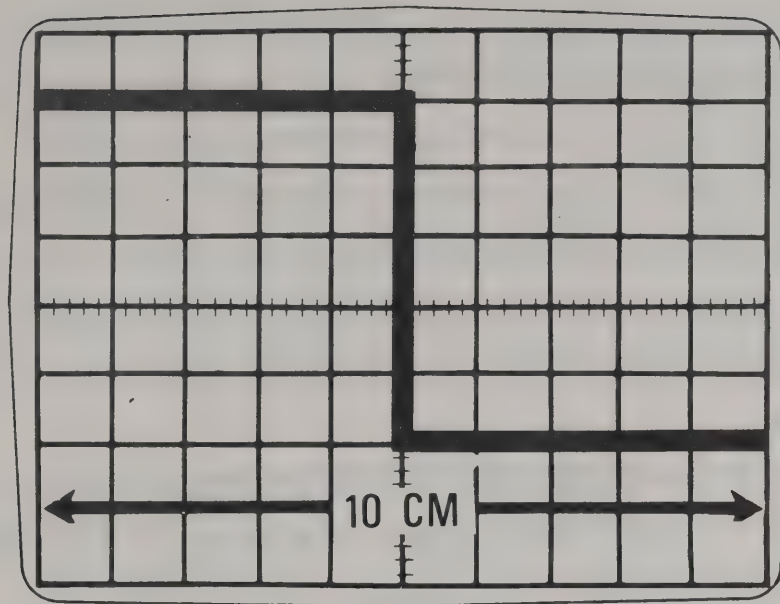
CHANGE THE TIME/DIV SWITCH TO ANOTHER SETTING THEN
 CALCULATE THE FREQUENCY. WHEN YOU CAN COMPUTE THE FREQUENCY
 IN LESS THAN 5 MINUTES, CONTINUE.



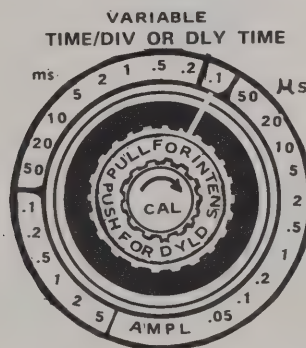
TO CALIBRATE THE SCOPE HORIZONTALLY, WE MUST USE A SIGNAL OF KNOWN FREQUENCY. YOU KNOW THAT THE OUTPUT FREQUENCY OF THE CALIBRATOR IS 1000 HZ WITH A VOLTAGE OF 1V. YOU WILL USE THIS TO CALIBRATE THE SCOPE.



TURN THE TIME/DIV SWITCH TO THE .1 MILLISECOND POSITION. ONE CYCLE WILL BE DISPLAYED ON THE SCREEN.



TO CALIBRATE THE SCOPE, WE MUST ADJUST THE SCOPE SO THAT 1 CYCLE OF SIGNAL COVERS EXACTLY 10 CM'S OF HORIZONTAL DEFLECTION.



ROTATE THE CAL CONTROL SLOWLY UNTIL THE DISPLAYED SIGNAL OF 1 CYCLE COVERS EXACTLY 10 CM'S HORIZONTALLY. THE SCOPE IS NOW CALIBRATED HORIZONTALLY. ANY SIGNAL INPUT WILL BE DISPLAYED TO SCALE ON THE SCREEN. YOU CAN USE THE METHOD IN THE PREVIOUS PARAGRAPHS TO COMPUTE THE FREQUENCY.

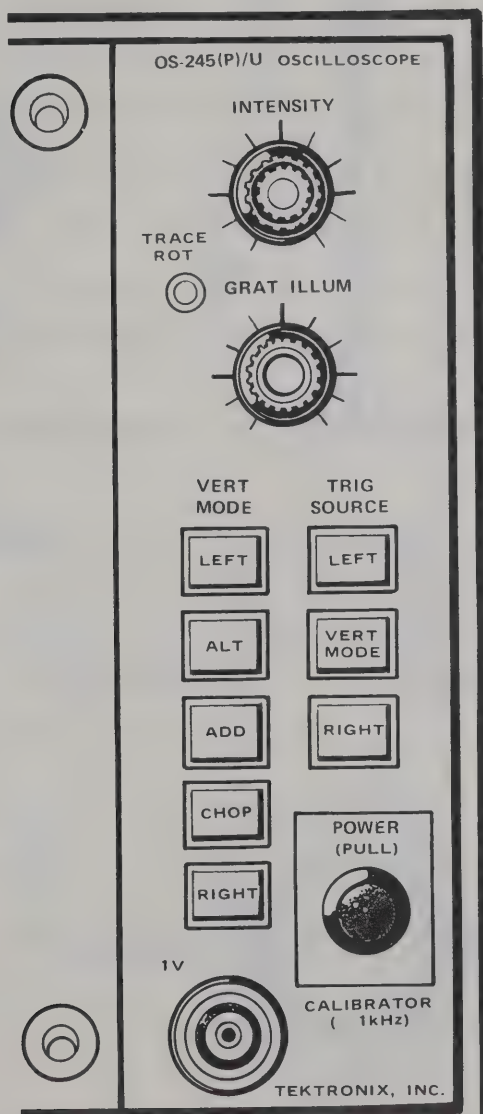
C A U T I O N: DO NOT TURN THE CAL CONTROL AFTER YOU HAVE
CALIBRATED THE SCOPE.

WHEN YOU CAN EASILY CALIBRATE THE SCOPE, HAVE YOUR OJT
MONITOR CHECK YOUR WORK TO BE SURE YOU HAVE MADE NO MISTAKES.
TURN ALL OF THE CONTROLS TO RANDOM SETTINGS AND PRACTICE
DISPLAYING THE VARIOUS WAVEFORMS PROVIDED BY YOUR QUALIFIED
OPERATOR AND IN EACH CASE DETERMINE THE FREQUENCY OF THE
DISPLAYED SIGNAL.

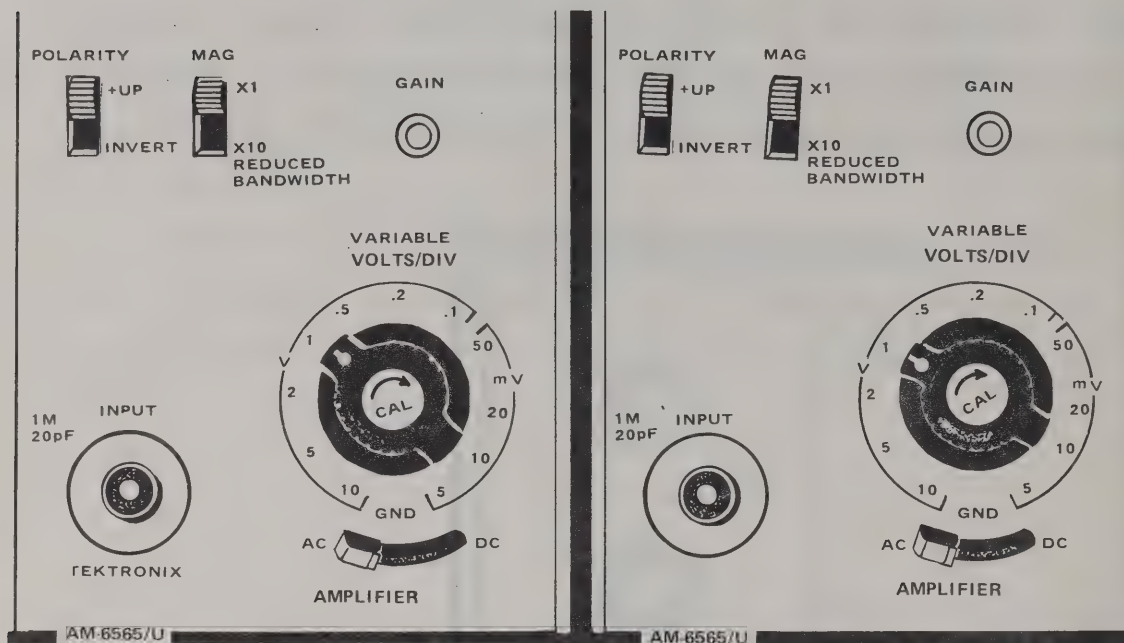
WHEN YOU CAN TURN ON THE AN/USM-281C AND ADJUST IT FOR A
TRACE, CALIBRATE IT FOR SINGLE CHANNEL OPERATION, MEASURE THE
VOLTAGE AND FREQUENCY OF AN INPUT SIGNAL, YOU ARE READY TO
ADVANCE TO MORE COMPLEX OPERATION OF THE SCOPE.

PERFORM THE FUNCTIONS REQUIRED TO VIEW AND COMPARE TWO SIGNALS AT THE SAME TIME AND TO ADD THEM ALGEBRAICALLY

THE VERT MODE COLUMN HAS FIVE SWITCHES. THEY ARE USED TO SELECT THE SIGNALS TO BE DISPLAYED ON THE CRT. YOU HAVE ALREADY USED THE LEFT AND RIGHT SWITCHES. IT IS POSSIBLE TO VIEW TWO SIGNALS AT THE SAME TIME USING THE ALT OR CHOP SWITCHES.

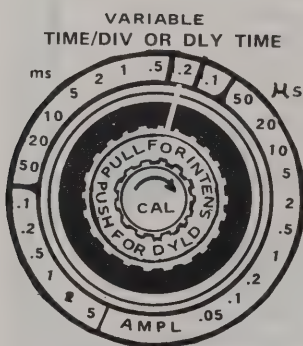


PLACE A SIGNAL INTO BOTH LEFT AND RIGHT CHANNELS FROM THE CALIBRATOR. USE THE T CONNECTOR AND TWO COAXIAL CABLES TO DO THIS.

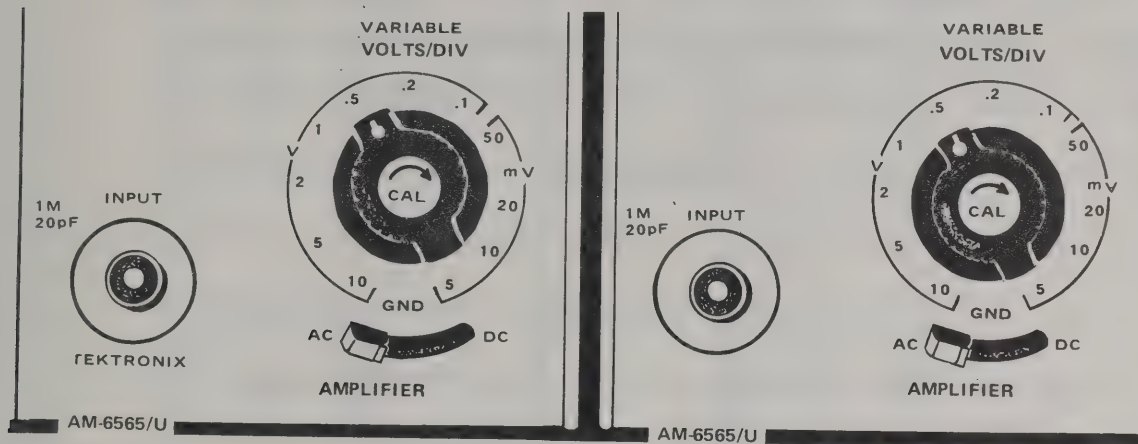


PRESS THE LEFT VERT MODE PUSH BUTTON IN.

SET THE TIME/DIV OR DLY TIME SWITCH TO THE .2 MS POSITION.

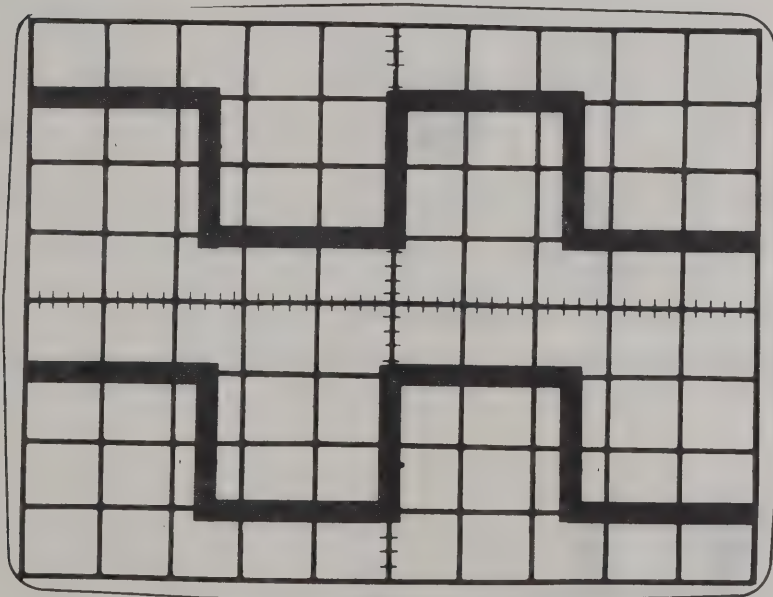


SET THE VOLTS/DIV SWITCH OF THE LEFT VERTICAL AMPLIFIER TO THE .5V PER CM POSITION. POSITION THIS SIGNAL ON THE TOP PORTION OF THE SCREEN.



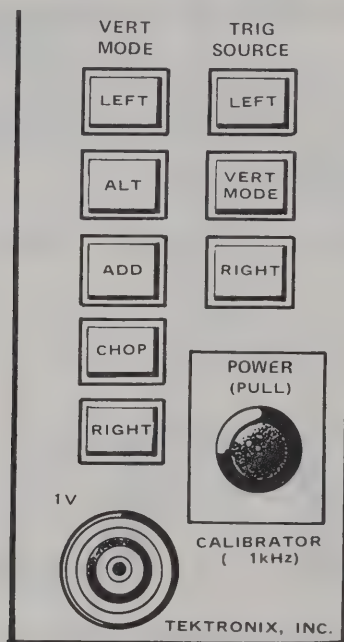
SET THE RIGHT CHANNEL CONTROLS TO THE SAME POSITION AS THE LEFT AND PRESS THE RIGHT VERT MODE SWITCH. POSITION THIS SIGNAL ON THE LOWER PORTION OF THE SCREEN.

PRESS THE VERT MODE CHOP PUSH BUTTON.



IT MAY BE NECESSARY TO ADJUST THE LEVEL CONTROL TO STABILIZE THESE TWO SIGNALS. YOU HAVE TWO SIGNALS DISPLAYED ON THE SCREEN. YOU CAN NOW COMPARE THE AMPLITUDE AND TIME DURATION OF THE TWO SIGNALS. YOU MAY ALSO USE THE ALT SWITCH FOR DISPLAY OF TWO SIGNALS. WHEN ALT IS USED, THE TRIG SOURCE LEFT OR RIGHT MUST BE USED.

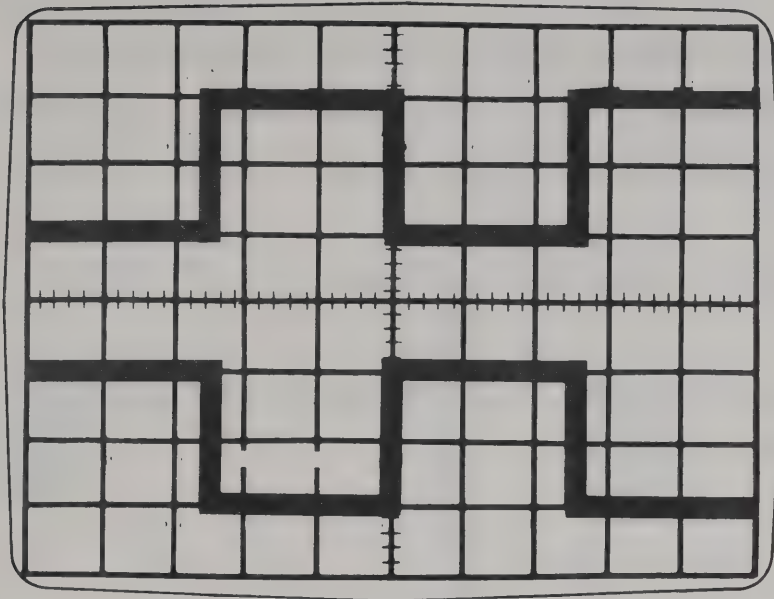
PRESS THE RIGHT PUSHBUTTON IN THE TRIG SOURCE COLUMN.



PLACE THE POLARITY SWITCH OF THE LEFT VERTICAL AMPLIFIER TO THE INVERT POSITION.



NOTICE HOW THE TOP SIGNAL CHANGES POLARITY.



IF YOU DESIRE TO CHANGE THE POLARITY OF THE BOTTOM SIGNAL THE TRIG SOURCE LEFT SWITCH MUST BE PRESSED IN ADDITION TO USING THE POLARITY SWITCH OF THE RIGHT VERTICAL AMPLIFIER. IF BOTH POLARITY SWITCHES ARE PLACED IN THE INVERT POSITION, THE SCOPE WILL AUTOMATICALLY DISPLAY THE POSITIVE CYCLE FIRST ON WAVEFORMS.

PRACTICE VIEWING TWO SIGNALS USING BOTH THE CHOP AND ALT SWITCHES OF THE VERT MODE COLUMN OF SWITCHES. WHEN YOU CAN DISPLAY TWO SIGNALS AT THE SAME TIME AND COMPARE THEIR AMPLITUDE AND TIME DURATION IN LESS THAN 5 MINUTES, YOU MAY CONTINUE.

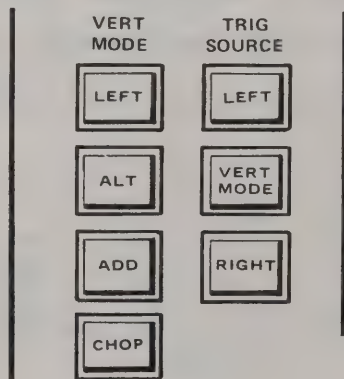
A VERY USEFUL FEATURE OF THE AN/USM-281C IS THE ALGEBRAIC ADD. YOU CAN USE THIS FUNCTION TO COMPARE TWO SIGNALS AND SEE HOW THEY DIFFER BY COMBINING THE TWO SIGNALS. BEFORE WE USE IT, LET'S REVIEW THE RULES OF ALGEBRAIC ADDITION.

1. 2 POSITIVE QUANTITIES = POSITIVE RESULT. $(+2A) + (+3A) = +5A$.
2. 2 NEGATIVE QUANTITIES = NEGATIVE RESULT $(-2A) + (-3A) = -5A$.
3. 1 NEGATIVE QUANTITY AND 1 POSITIVE QUANTITY = RESULTANT SIGN OF LARGER QUANTITY.
 - A. $(-2A) + (+3A) = +1A$
 - B. $(+2A) + (-3A) = -1A$
 - C. $(+2A) + (-2A) = 0$

EXAMPLE 3C IS VERY IMPORTANT. IF YOU ADD TWO EQUAL QUANTITIES OF OPPOSITE SIGNS THE RESULT IS ZERO. THEY CANCEL EACH OTHER. WE WILL USE THIS PRINCIPLE EXTENSIVELY. TO USE THE ALGEBRAIC ADD FUNCTION, USE THE FOLLOWING PROCEDURE.

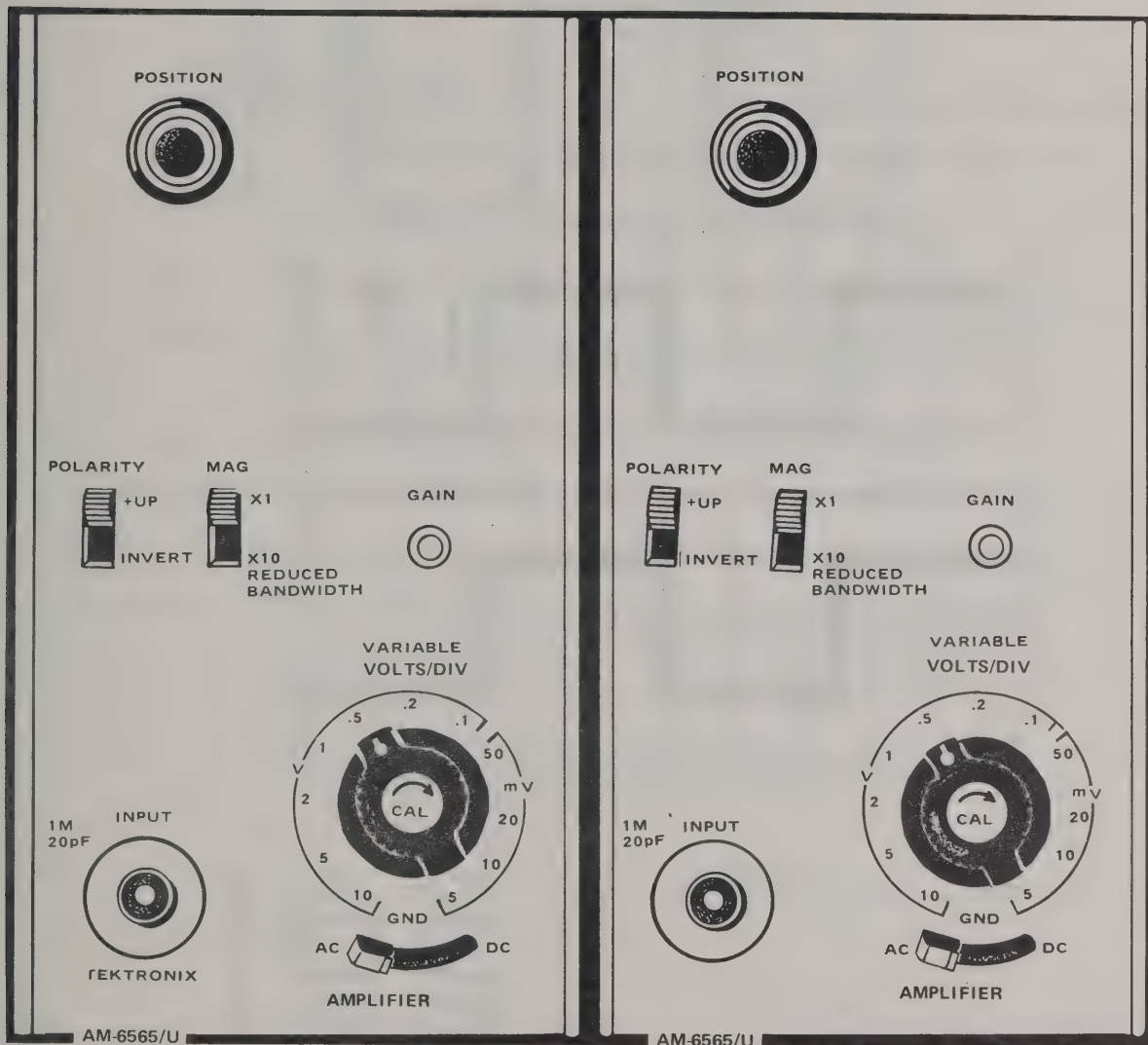
TO ADD TWO +1 VOLT SIGNALS:

PUSH IN THE CHOP BUTTON UNDER THE VERT MODE COLUMN OF PUSHBUTTONS.

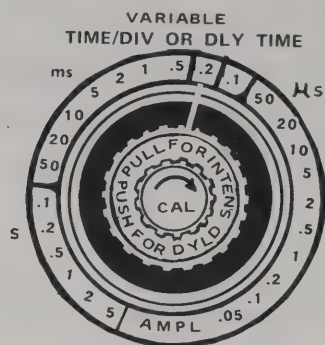


PLACE A 1-VOLT SIGNAL FROM THE CALIBRATOR INTO BOTH
VERTICAL AMPLIFIERS.

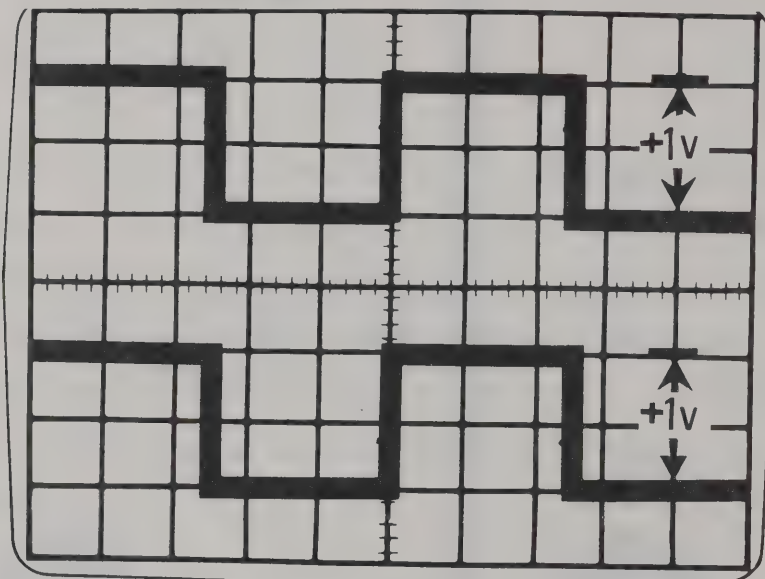
SET THE POLARITY SWITCH FOR EACH CHANNEL TO THE +UP
POSITION.



SET THE TIME/DIV OR DLY TIME SWITCH TO .2 MSEC.



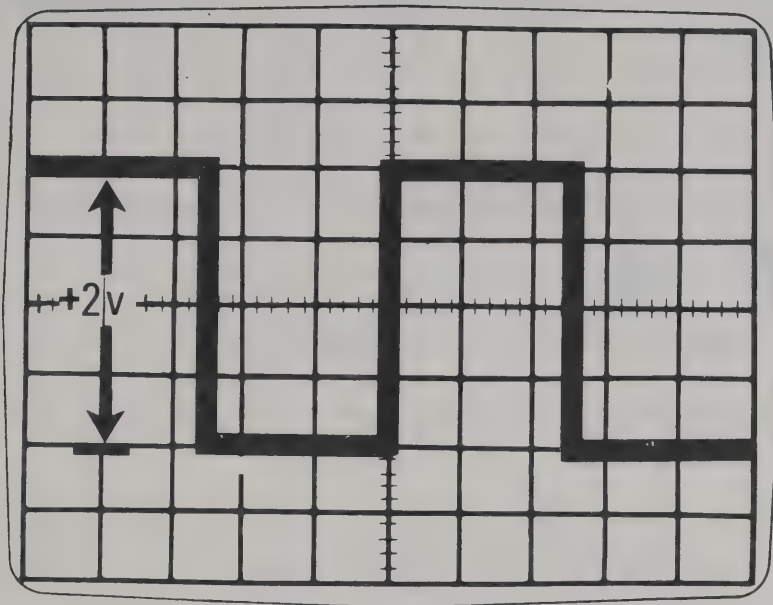
DISPLAY THE TWO SIGNALS PLACING THE LEFT CHANNEL ON THE TOP AND THE RIGHT CHANNEL ON THE BOTTOM OF THE SCREEN.



NOW PRESS THE ADD SWITCH.

VERT MODE	TRIG SOURCE
LEFT	LEFT
ALT	VERT MODE
ADD	RIGHT

YOU ARE ADDING THE TWO SIGNALS AND THE RESULT IS A +2 VOLT SIGNAL.



LET'S CHECK THE SIGNAL SHOWN. IT HAS THE SAME FREQUENCY AS BOTH ORIGINAL SIGNALS, WHICH WERE BOTH SQUARE WAVES. BOTH ORIGINAL SIGNALS WERE 1 VOLT AND 2 CM'S AMPLITUDE EACH. THEY HAVE BEEN ADDED TOGETHER AND NOW HAVE AN AMPLITUDE OF 4 CM'S OR +2 VOLTS. EVALUATE THE ORIGINAL INPUTS ALGEBRAICALLY.

$$A + B = C$$

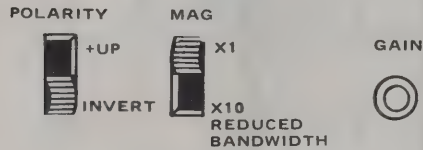
$$A = +1 \text{ VOLT}$$

$$B = +1 \text{ VOLT}$$

$$(+1V) (+1V) = C$$

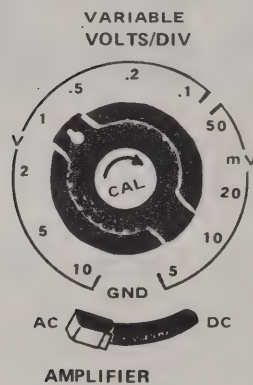
$$C = +2 \text{ VOLTS}$$

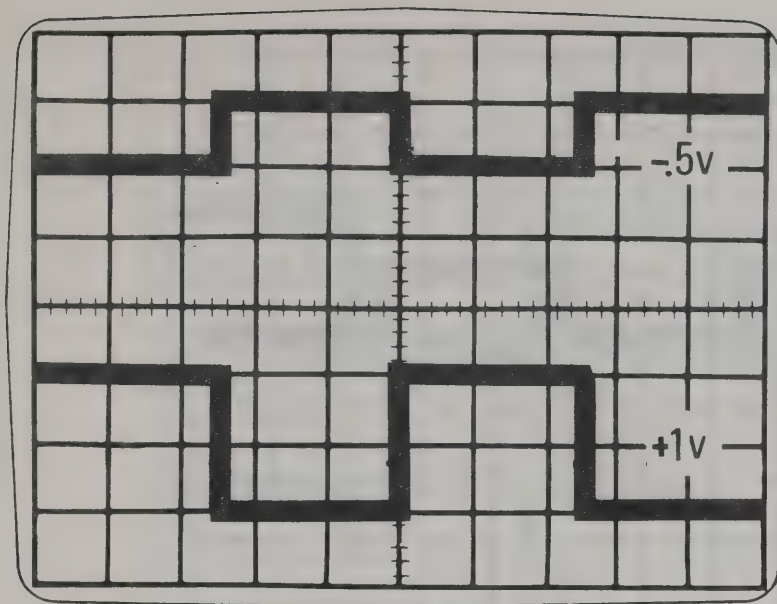
TO ADD A $-.5$ VOLT AND A $+1$ VOLT:
 PUSH IN THE CHOP SWITCH IN THE VERT MODE COLUMN OF SWITCHES.
 PLACE THE POLARITY SWITCH OF THE LEFT VERTICAL AMPLIFIER
 TO THE INVERT POSITION.



WE DON'T HAVE A SOURCE FOR A $-.5$ VOLT SIGNAL. WE WILL
 USE THE CALIBRATOR TO SIMULATE A $-.5$ VOLT SIGNAL.

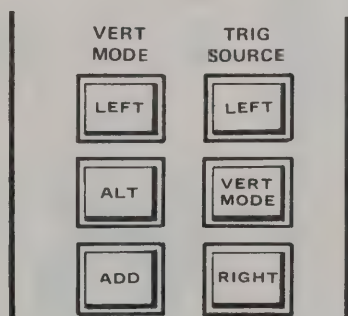
TURN THE VOLTS/DIV SWITCH OF THE LEFT VERTICAL AMPLIFIER
 TO THE 1-VOLT POSITION.



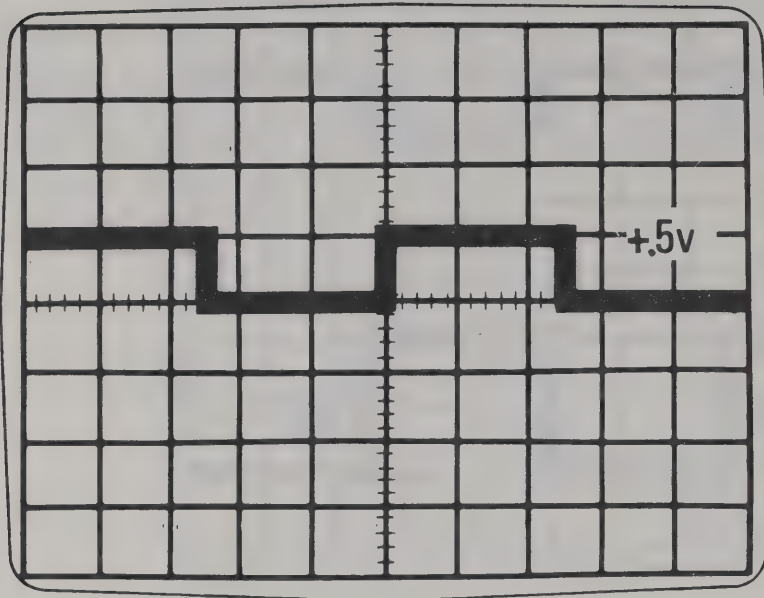


THE SIGNAL WILL NOW COVER 1 CM. COMPARING IT TO THE +1 VOLT SIGNAL OF 2 CM'S, IT WILL BE 1/2 THE AMPLITUDE; THEREFORE IT WILL SIMULATE A -.5 VOLT SIGNAL.

NOW PRESS THE ADD SWITCH.

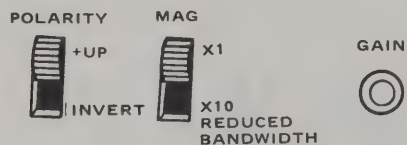


THE SIGNALS HAVE BEEN ADDED ALGEBRAICALLY. THE RESULT IS A +.5 VOLT SIGNAL OF THE SAME FREQUENCY AS THE INPUTS. USING THE ALGEBRAIC FORMULA CHECK YOUR RESULTS. $A + B = C$
 $A = -.5 \text{ VOLTS}$ $B = +1 \text{ VOLT}$ $(-.5) + (+1) = C$ $C = +.5 \text{ VOLTS.}$

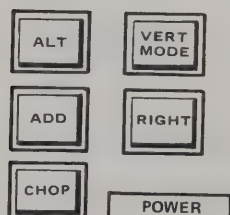


THE MOST IMPORTANT USE OF THE ADD FUNCTION IS TO COMPARE TWO SIGNALS TO DETERMINE IF THEY ARE IDENTICAL.

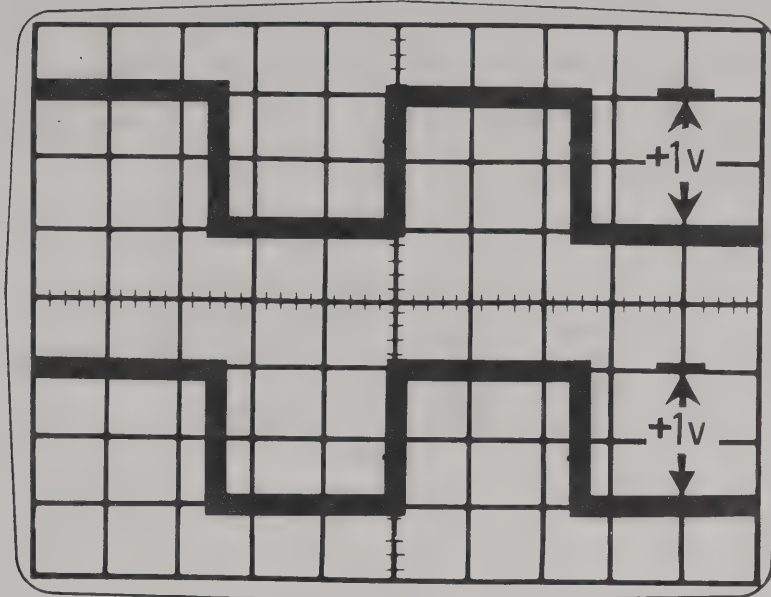
RETURN THE LEFT POLARITY SWITCH TO THE +UP POSITION.



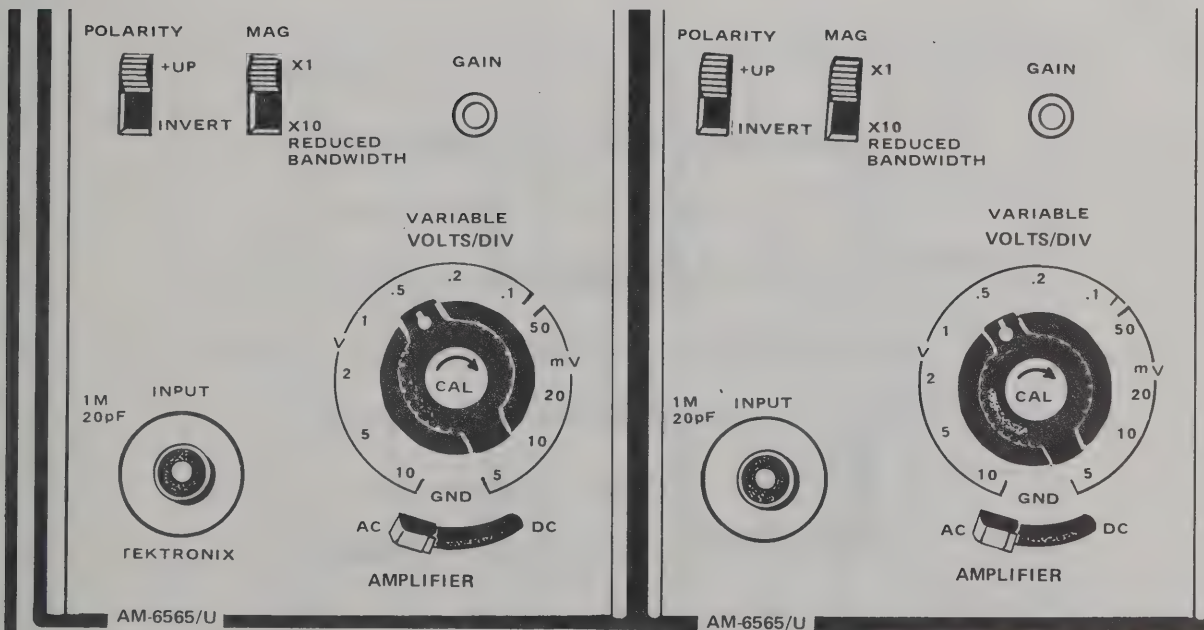
PRESS THE CHOP PUSHBUTTON IN THE VERT MODE COLUMN.



PLACE A +1 VOLT SIGNAL INTO EACH CHANNEL FROM THE CALIBRATOR.

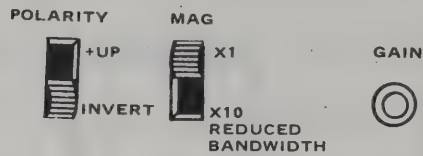


SET BOTH VOLTS/DIV SWITCHES TO .5V.

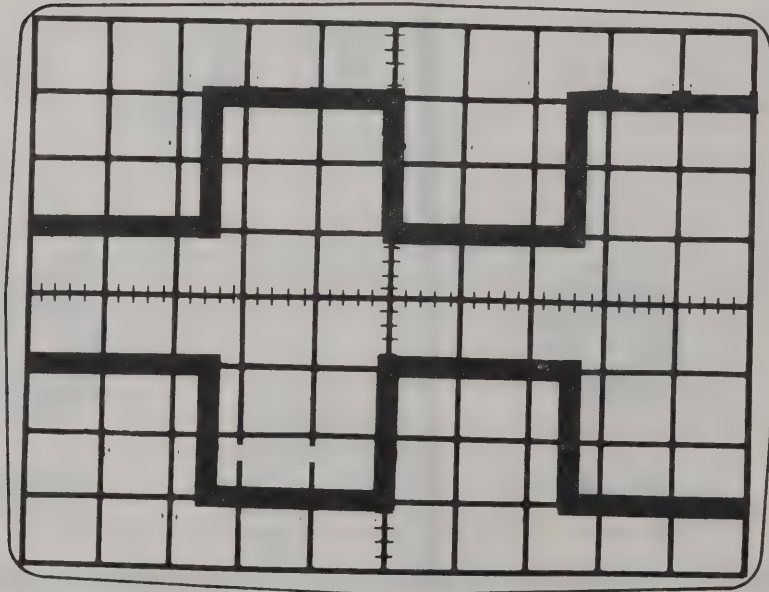


IT IS HARD TO COMPARE THESE TWO SIGNALS IN THIS MANNER TO DETERMINE IF THEY ARE OF THE SAME FREQUENCY AND AMPLITUDE. THE SIGNALS APPEAR TO BE THE SAME USING THIS TYPE OF COMPARISON.

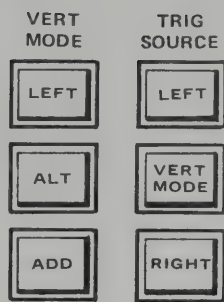
CHANGE THE POLARITY SWITCH OF THE LEFT VERTICAL AMPLIFIER TO THE INVERT POSITION.



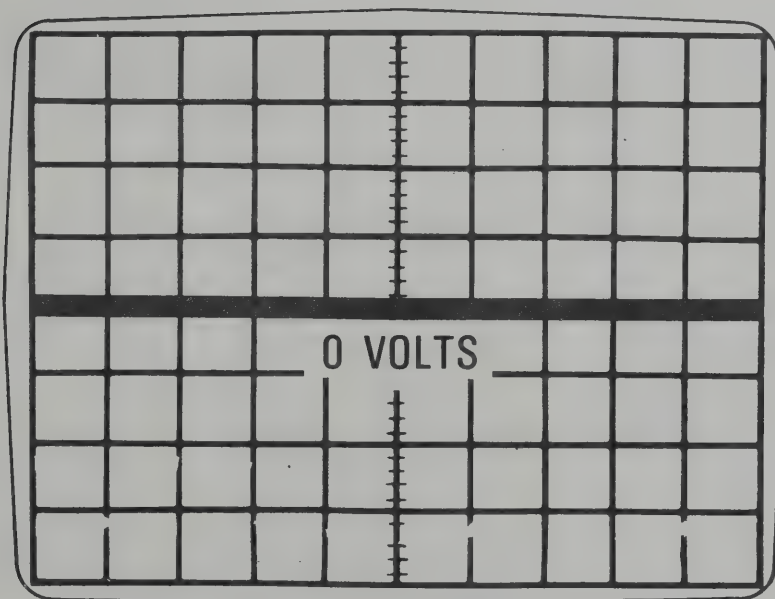
THE TWO SIGNALS ARE 180 DEGREES OUT OF PHASE.



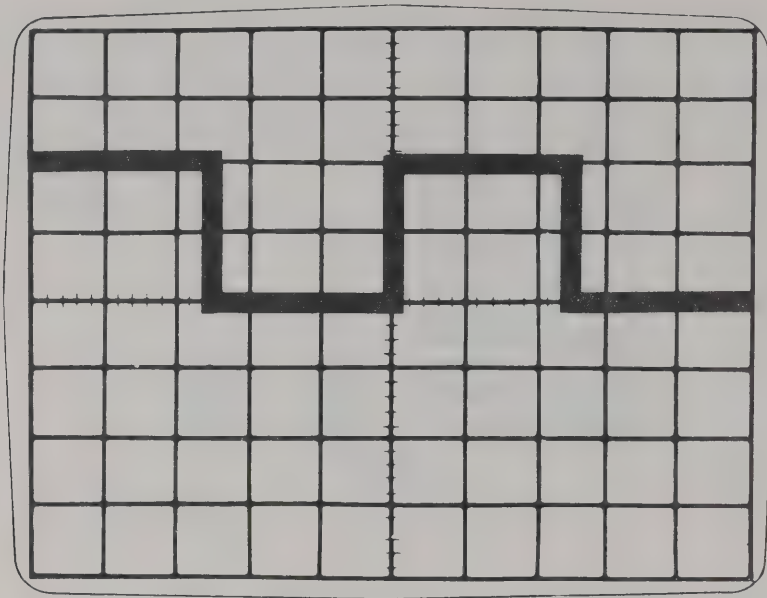
PRESS THE ADD SWITCH IN THE VERT MODE COLUMN.



IF THE TWO SIGNALS ARE 180 DEGREES OUT OF PHASE THEY WILL CANCEL AND THE RESULT WILL BE A STRAIGHT LINE AS SHOWN.



REMOVE THE INPUT FROM THE LEFT VERTICAL AMPLIFIER.



USE THE ADD FUNCTION TO CHECK TWO IDENTICAL SIGNALS. IF THE SIGNALS ARE NOT IDENTICAL THE DIFFERENCE WILL BE DISPLAYED ON THE SCOPE.

PRACTICE COMPARING TWO IDENTICAL SIGNALS USING THE ADD FUNCTION. WHEN YOU CAN CHECK TWO SIGNALS IN LESS THAN 5 MINUTES, ASK YOUR QUALIFIED OPERATOR TO CHECK YOUR WORK. YOUR QUALIFIED OPERATOR WILL PROVIDE WAVEFORMS FOR YOU TO COMPARE.

1. Intensity control
2. Focus control
3. Trace Totation control
4. Grati Illum control
5. Beam Finder switch

VERTICAL MODE switches

6. Left
7. Alt
8. Add
9. Chop
10. Right

TRIG SOURCE switches

11. Left
12. Vert Mode
13. Right
14. Power switch
15. Calibrator connector
16. Vertical Position control
17. Polarity switch
18. Mag switch
19. Gain control
20. Input connector
21. Volts/Div switch
22. Variable Volts/Div switch
23. AC/Gnd/DC switch
24. Level control
25. Slope switch
26. Trigd indicator

MAIN TRIGGERING AMPLIFIER

MODE switches

27. Auto
28. Norm
29. Single Swp
30. Reset-Ready

AMPLIFIER COUPLING switches

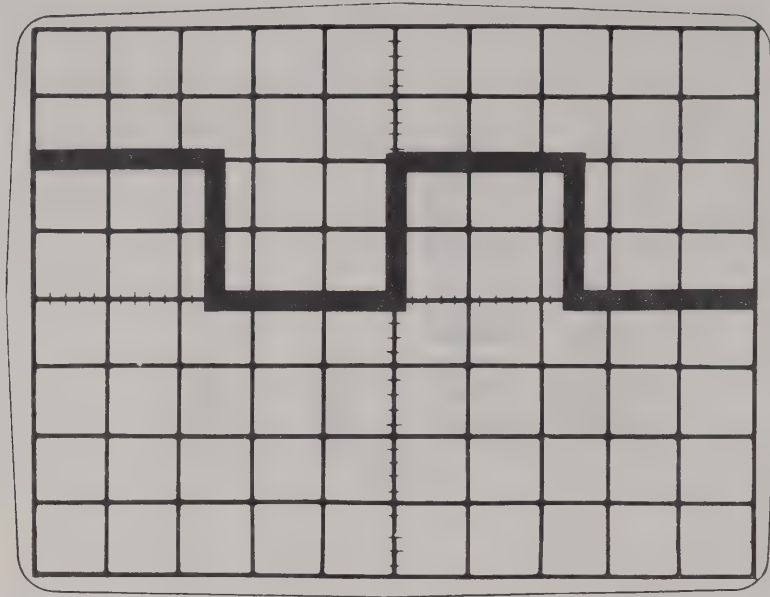
31. AC
32. AC LF Rej
33. AC HF Rej
34. DC

AMPLIFIER SOURCE switches

35. Int
36. Line

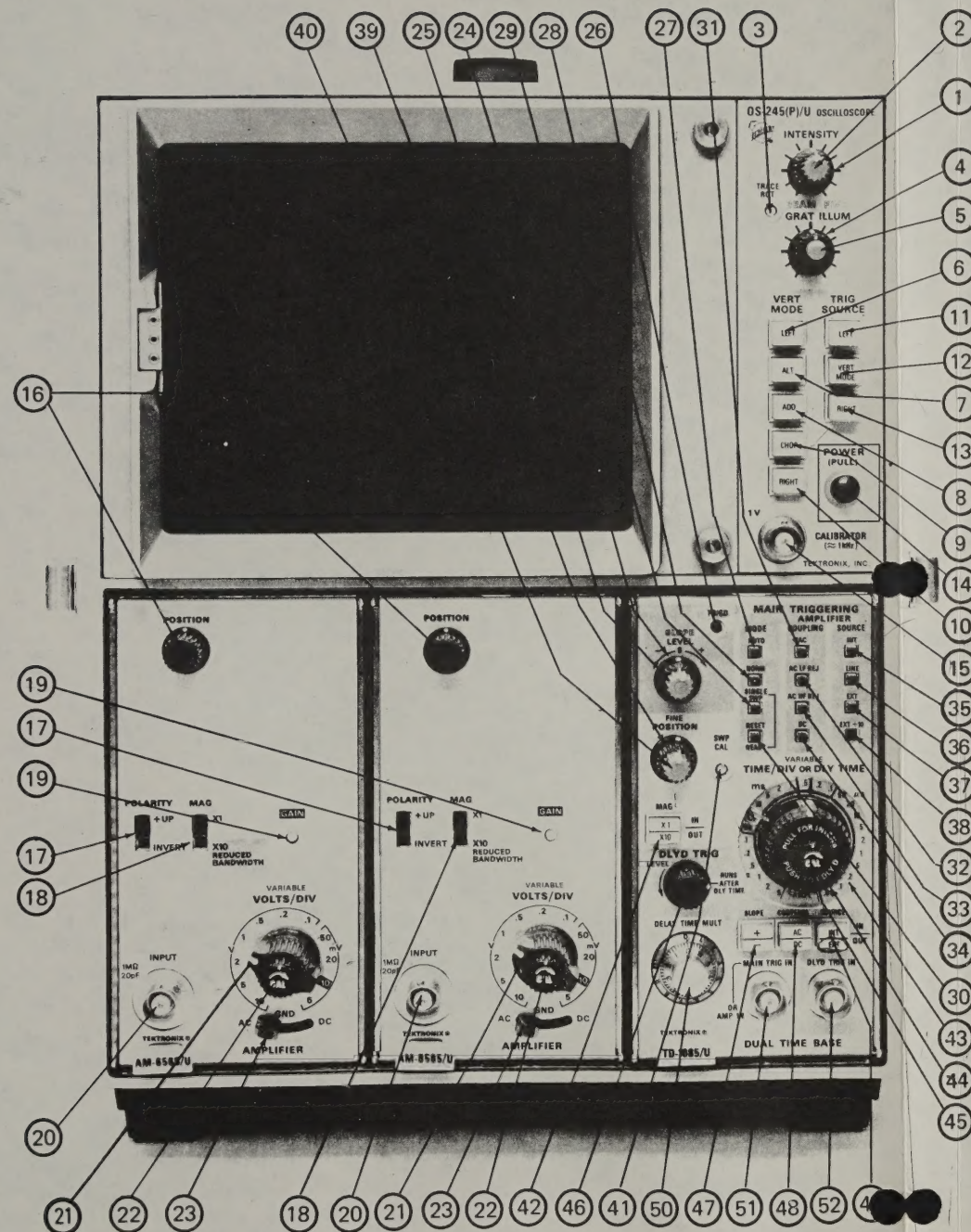
37. Ext
38. Ext \div 10
39. Position control
40. Fine control
41. Swp Cal control
42. Mag switch
43. Time/Div or Dly Time switch
44. Delayed time/division, intensify switch
45. Variable control
46. Dlyd trig switch
47. Slope switch
48. Coupling switch
49. Source switch
50. Delay time Mult 10 switch
51. Main trig In or Amp In jack
52. Dlyd trig in

REMOVE THE INPUT FROM THE LEFT VERTICAL AMPLIFIER.



USE THE ADD FUNCTION TO CHECK TWO IDENTICAL SIGNALS. IF THE SIGNALS ARE NOT IDENTICAL THE DIFFERENCE WILL BE DISPLAYED ON THE SCOPE.

PRACTICE COMPARING TWO IDENTICAL SIGNALS USING THE ADD FUNCTION. WHEN YOU CAN CHECK TWO SIGNALS IN LESS THAN 5 MINUTES, ASK YOUR QUALIFIED OPERATOR TO CHECK YOUR WORK. YOUR QUALIFIED OPERATOR WILL PROVIDE WAVEFORMS FOR YOU TO COMPARE.



- | | |
|---|---|
| 1. Intensity control | 37. Ext |
| 2. Focus control | 38. Ext $\div 10$ |
| 3. Trace Totation control | 39. Position control |
| 4. Grati Illum control | 40. Fine control |
| 5. Beam Finder switch | 41. Swp Cal control |
| VERTICAL MODE switches | |
| 6. Left | 42. Mag switch |
| 7. Alt | 43. Time/Div or Dly Time switch |
| 8. Add | 44. Delayed time/division, intensify switch |
| 9. Chop | 45. Variable control |
| 10. Right | 46. Dlyd trig switch |
| TRIG SOURCE switches | |
| 11. Left | 47. Slope switch |
| 12. Vert Mode | 48. Coupling switch |
| 13. Right | 49. Source switch |
| 14. Power switch | 50. Delay time Mult 10 switch |
| 15. Calibrator connector | 51. Main trig In or Amp In jack |
| 16. Vertical Position control | 52. Dlyd trig in |
| 17. Polarity switch | |
| 18. Mag switch | |
| 19. Gain control | |
| 20. Input connector | |
| 21. Volts/Div switch | |
| 22. Variable Volts/Div switch | |
| 23. AC/Gnd/DC switch | |
| 24. Level control | |
| 25. Slope switch | |
| 26. Trigd indicator | |
| MAIN TRIGGERING AMPLIFIER MODE switches | |
| 27. Auto | |
| 28. Norm | |
| 29. Single Swp | |
| 30. Reset-Ready | |
| AMPLIFIER COUPLING switches | |
| 31. AC | |
| 32. AC LF Rej | |
| 33. AC HF Rej | |
| 34. DC | |
| AMPLIFIER SOURCE switches | |
| 35. Int | |
| 36. Line | |





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